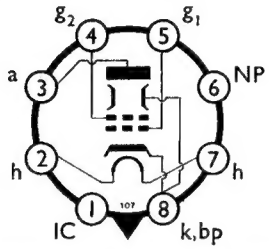
BEAM TETRODE
0·3A INDIRECTLY HEATED

KT55

DECEMBER, 1955

The KT55 may be used as an audio output valve or as a series stabiliser.

BASE CONNECTIONS AND VALVE DIMENSIONS



View from underside of base.

Base : International octal.
Bulb : Dome top tubular.

Max. overall length :	143	mm.
Max. seated length :	128	mm.
Max. diameter :	52	mm.

HEATER

I_h	0·3	A
V_h	52	V

MAXIMUM RATINGS

V_a	400	V
V_{g2}	300	V
$V_{h\text{-}k}$	250	V
$v_{h\text{-}k\ (pk)}$	350	V
P_a	25	W
P_{g2}	4·5	W
$P_a + _{g2}$	26·5	W

CAPACITANCES (of cold unscreened valve)

$c_{a\text{-all}}$	14	pF	$c_{g1\text{-all}}$	34	pF	$c_{a\text{-}g1}$	0·7	pF

CHARACTERISTICS

	Tetrode Connection	Triode Connection	
V_a	200	200	V
V_{g2}	150	—	V
V_{g1}	−13·5 approx.	−20 approx.	V
I_a	125	140	mA
I_{g2}	7·5	—	mA
μ	—	7·5	—
g_m	19	20	mA/V
r_a	5000	400	Ω

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KT55

TYPICAL OPERATION

Tetrode Connection. Push-pull. Two Valves.

Data per pair unless otherwise stated.

	Quiescent	Max. signal	
$V_{a(b)}$	225	215	V
V_a	200	190	V
V_{g2}	200	190	V
$v_{in\ (g1\text{-}g1)}$ (pk)	—	28·8	V
V_{g1} (approx.)	−22	−25	V
I_a	220	225	mA
I_{g2}	15	45	mA
R_k (per valve)	185	185	Ω
$R_{L\ (a\text{-}a)}$	—	2	kΩ
P_{out}	—	25	W
D	—	2	%
z_{out}	—	9	kΩ

Triode Connection. Push-pull. Two Valves.

Data per pair unless otherwise stated.

$V_{a(b)}$	200	225	V
V_a	180	200	V
V_{g1}	−19	−22	—
I_a	205	240	mA
p_a (per valve)	18·5	22	W
R_k	185	185	Ω
$R_{L\ (a\text{-}a)}$	1·5	1·5	kΩ
P_{out}	11	15	W
$D_{max.}$	2	—	%
V_{in} (rms)	13+13	15+15	V
z_{out}	1	1	kΩ

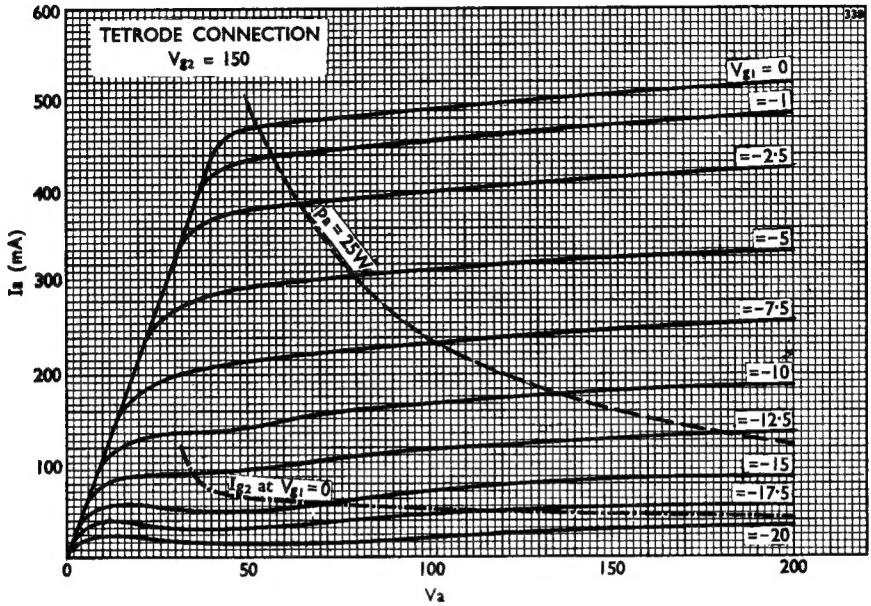
NOTE The anode current rises by about 10 mA for full output.

MOUNTING

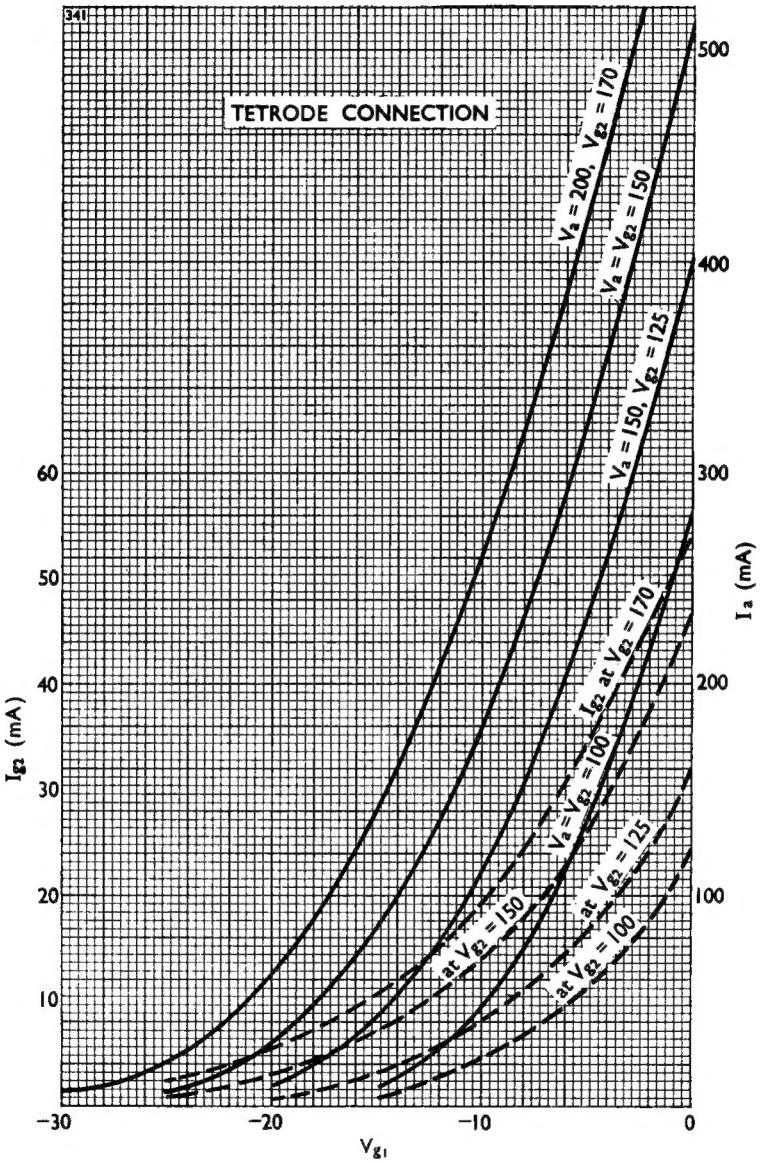
Vertical. Base down.

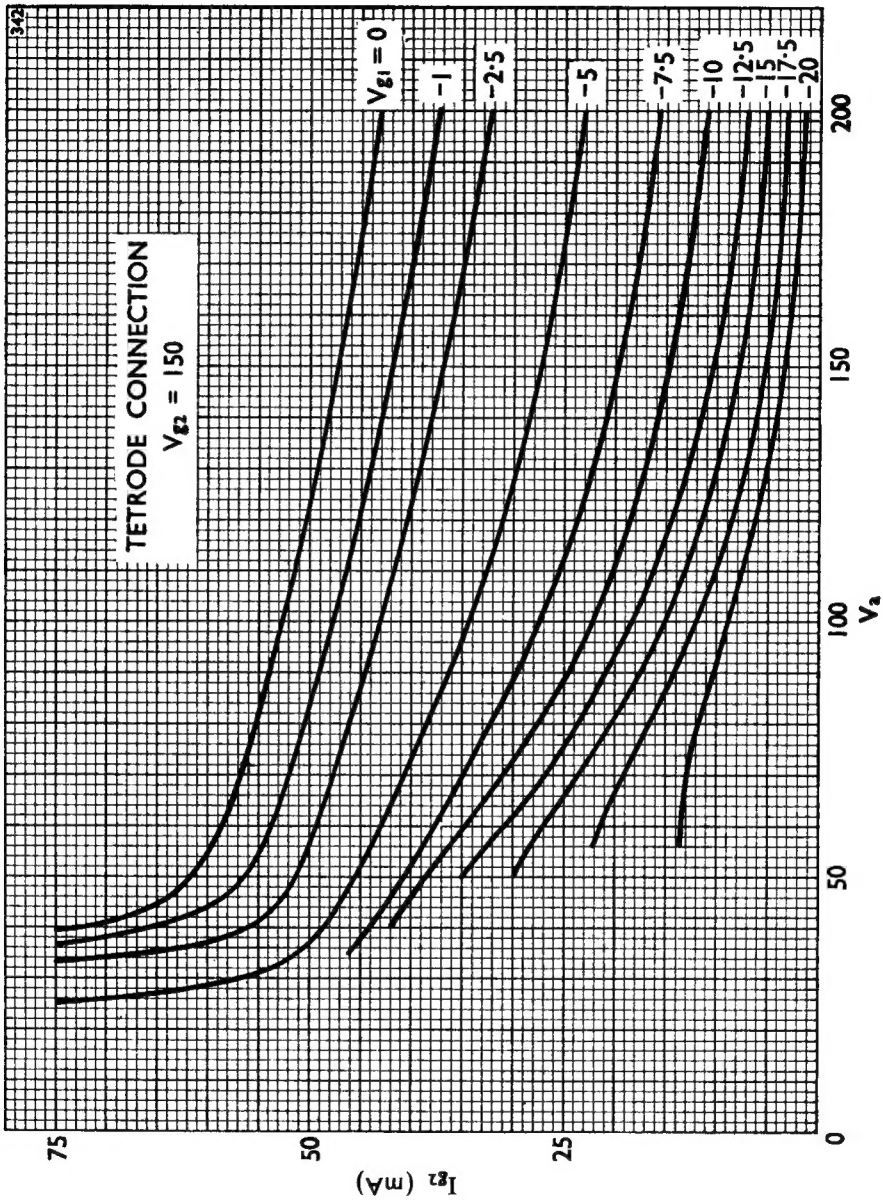
VENTILATION

Free air circulation is desirable. The temperature of the hottest part of the bulb must not exceed 225°C.

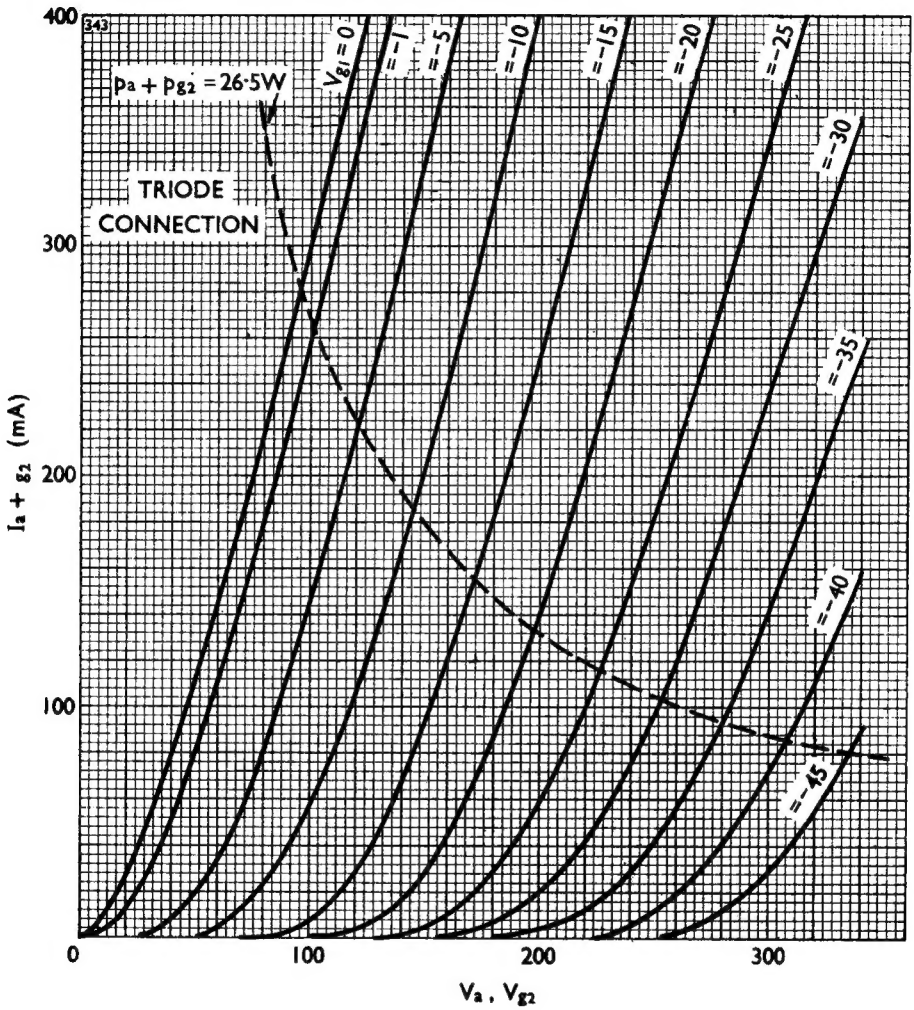

TETRODE CONNECTION
V_{g2} = 150
V_{g1} = 0
=-1
=-2·5
=-5
=-7·5
=-10
=-12·5
=-15
=-17·5
=-20
P_a = 25W
I_{g2} at V_{g1} = 0
I_a (mA)
V_a
600
500
400
300
200
100
0
50
100
150
200

KT55


341
TETRODE CONNECTION
Va = 200, Vg2 = 170
Va = Vg2 = 150
Va = 150, Vg2 = 125
Ig2 at Vg2 = 170
Va = Vg2 = 100
at Vg2 = 150
at Vg2 = 125
at Vg2 = 100
Ig2 (mA)
Ia (mA)
Vg1
60
50
40
30
20
10
500
400
300
200
100
−30
−20
−10
0


342
TETRODE CONNECTION
V_{g2} = 150
V_{g1} = 0
-1
-2·5
-5
-7·5
-10
-12·5
-15
-17·5
-20
I_{g2} (mA)
75
50
25
0
50
100
150
200
V_a

KT55


343
$p_a + p_{g2} = 26{\cdot}5W$
TRIODE CONNECTION
$V_{g1} = 0$
$= -1$
$= -5$
$= -10$
$= -15$
$= -20$
$= -25$
$= -30$
$= -35$
$= -40$
$= -45$
400
300
200
100
0
100
200
300
$I_a + g_2$ (mA)
V_a , V_{g2}

KT55

OV.3256

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CIRCUIT SUPPLEMENT

KT55

DECEMBER, 1955

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INTRODUCTION

The KT55 is primarily designed for use as an audio frequency amplifier in AC/DC equipment using a series connected heater chain. Two valves will provide an output of the order of 25W with a line voltage of 225V.

The recommended circuit is shown in fig. 1 and is designed round one Z729, one L63, and two KT55 valves, the H.T. supply being provided by a metal rectifier when the amplifier is operated on AC mains. The use of a thermionic rectifier is impracticable due to the high current required, which is about 275 mA.

The input signal is applied to a Z729 voltage amplifier. This is followed by an L63 phase splitter which provides two equal voltages of opposite phase to the two KT55 output valves.

The two KT55 valves, which must have separate cathode bias resistors, R16, R17, have their anodes connected to an output transformer, details of which are given later. The anode current is supplied by a low impedance rectifier and smoothing system which utilises components common in television receivers. A tapped resistor caters for various AC and DC mains voltages. The heater current is controlled by a barretter Type 303 and thermistor CZ1.

The basic sensitivity of this amplifier is high, full output being obtainable from an input of 55 mV. This is increased to 300 mV by the application of degeneration. The sum and noise level is 55db below full output before degeneration is applied, the volume control being at maximum.

Separate bias resistors, R16 R17, are essential due to the high mutual conductance. The 50 μF capacitors, C8 C9, permit a loss of 6db at 500 c/s. They may be increased to 250 μF where this loss is objectionable.

ULTRA LINEAR OPERATION

The output stage may be connected so that the valves operate either as pentodes or in the ultra linear mode. The latter is shown in fig. 1 but the resistors R14 R15 may be connected to C13 for pentode operation. The ultra linear circuit gives a reduction in output impedance from 9 kΩ to 2·35 kΩ, giving a unity ratio with the anode to anode load. The distortion falls from 2% to 1·5%. These advantages are accompanied by a slight increase in the input signal required.

The output transformer Ref. C2203, for the ultra linear circuit, is provided with a tap on each half-primary at one fifth of the turns, measured from the centre tap. Two small capacitors, C10 C11, are required to prevent self-oscillation under certain operating conditions.

Satisfactory performance as pentodes has been obtained either with the special output transformer Ref. C2203 or with PPO/15. Both are made by Partridge Transformers Ltd. Their characteristics are :

	C2203	PPO/15
Primary inductance	12·5 H	20 H
Primary resistance	52Ω	90Ω
Leakage inductance	15 mH	20 mH
Ratio	16 or 32 : 1	14 or 28 : 1

The output transformer ratio will depend on the impedance of the loudspeaker system and may be determined by $\sqrt{\frac{2000}{Z_s}}$ (Z_s=speech coil impedance) for the pentode and ultra linear circuits.

Degeneration is applied over three stages, about 14db giving a satisfactory reduction in distortion and output impedance without leading to oscillation. With the recommended transformers it is probable that more could be applied ; however, an output of 25W can be obtained with 0·5% distortion with the pentode connected circuit. The components, C14 R21, ensure stability by reducing the loop gain in the ultrasonic region, a loss of 6db at 20 kc/s is produced.

A low impedance power supply is required but this is easily provided by the use of components similar to those used in lower priced television receivers. The smoothing choke L1 has an inductance of about 2H with a DC resistance of 175Ω. This is used in conjunction with two electrolytic capacitors, C12 C13, having a total capacitance of 300 μF. A metal rectifier is used since the current at full output is 275 mA. A tapped resistor, R20, caters for AC and DC supply voltages up to 250. On DC mains this resistor is not in circuit and the metal rectifier protects the capacitors against reversed polarity.

PERFORMANCE

The performance of two KT55 valves connected as pentodes in the circuit shown in fig. 1, may be obtained from the curves shown in fig. 5. These curves are drawn to cover four different groups of mains voltages as follows :—

Curve A	AC, 180—215V
Curve B	AC, 200—240V
Curve C	AC, 220—265V
Curve D	DC, 200—265V

Two considerations were borne in mind when these curves were prepared, (*a*) the maximum dissipation of the KT55, and (*b*) the maximum rating of the metal rectifier.

For all DC supply voltages between 190 and 260 and for AC supply voltages between 190 and 215 no limiting resistance is required in series with the rectifier to meet the two conditions (*a*) and (*b*). With DC mains the rectifier to MR1 serves to protect the electrolytic capacitors against a reversed polarity. When an AC supply above 215V is used a series limiting resistor R20 is necessary and this is conveniently divided into two steps to cover operation up to 260V.

The curves are drawn with considerable overlap at the low voltage end in order to convey a complete picture of the performance, but it is suggested that the three mains taps be marked as follows :

1.	190—215V AC	190—260V DC
2.	215—235V AC	
3.	235—260V AC	

The heater current is maintained within the limits 285 mA to 315 mA by the G.E.C. barretter Type 303. A satisfactory performance will be obtained over a range rate more than the usual 200-250V without adjustment. The thermistor CZ1 controls the current during switching-on periods and prevents a surge of current when the valves are cold. No thermistor shunt is required.

OPERATION FROM SUB-NORMAL MAINS VOLTAGES

The KT55 may be used successfully when only a low DC mains voltage is available, as in some marine installations.

A curve (fig. 6) shows the expected output assuming DC mains voltages of 100-200.

The recommended circuit is similar to fig. 1 but, to prevent loss of voltage, the mains rectifier is omitted and the output transformer is connected to the live side of the smoothing choke. The capacitor C2 is also omitted and, C12 C13, become 4 μF paper capacitors.

The bias resistors are reduced to 150Ω and the optimum load is 1·5 kΩ.

The heater connections depend on the required operating voltage. From 150-200V the existing series arrangement may be used with a 305 barretter, this being replaced by a suitable resistor for 125-150V. Below 125V two chains will be used, the two KT55s being connected in series in one chain with a small resistor (if necessary) and a 303, 304 or 305 barretter with the remaining valves in the second chain. For low AC mains voltages an auto-transformer may be used for the anode supply, with the heaters connected as for DC mains.

An alternative method of supplying the anode voltage when low voltage AC mains are available is shown in fig. 4. A voltage doubler circuit is employed which gives a DC line voltage of 220 from 110V AC.

The smoothing choke used had a lower resistance of 20Ω and a rectifier Type RM5 replaced the RM4.

The performance obtained was as follows :

AC Voltage	*DC Line Voltage*	*Power Output*
110	200	19W
110	220	23W
120	235	27W

OTHER APPLICATIONS

D.C.-A.C. Converter

This unit is designed to supply about 25W at 200-250V, 50 c/s, from a DC mains output of 200-250V. The complete circuit arrangement is given in fig. 2.

The output stage consists of a pair of KT55s in push-pull using self bias. An output of between 20 and 25W is easily obtainable, depending on the mains supply voltage. For lower voltages, adjustment may be made by reducing the cathode bias resistors of the output valves to *not less than 150*Ω. For maximum output the 250 μF capacitors should be used.

A centre tapped inductor, or a transformer, may be used, with a suitable power-factor correcting capacitor when feeding a partly reactive load, such as a record-changer motor.

It is advisable to disconnect the HT supply when the load is removed, e.g., when an automatic record-changer is used. Current taken by the pair of valves is between 225 and 275 mA.

Considerable distortion of the output wave form may exist, especially with a motor as load, but this is of no consequence to the operation of the motor. The power factor correcting capacitor will be found to improve the waveform considerably. Some screen decoupling might be of advantage, especially when using rough or noisy DC mains.

The oscillator stage has a split load, part appearing between cathode and HT negative, part between anode and HT positive. This enables a push-pull signal to be obtained to drive the output valves.

A triode-connected Z77 is used as oscillator, with an R-C twin-T feedback network, tunable to 50 c/s. About 60V peak to peak is obtaintable across each half of the load.

Output may be adjusted by altering the value of the unbypassed cathode bias resistor. Between 33 and 47 kΩ should be used for each half load, larger values giving no increase in output.

Frequency stability is good, being little affected by supply voltage variations. Tests of short-period drift showed an increase in frequency of 0·25% after 40 minutes, when it appeared to have steadied. Long term stability has not been accurately measured, but appears good.

Series Heater Circuit

When the supply voltage lies between 220 and 225 the heaters of a group of four valves may be connected to it without an additional dropping resistor. If the voltage lies between 225 and 250, a tapped series resistor of 100Ω will be required. A thermistor, Type CZ1, shunted by 750Ω, is essential to restrain the cold switching current. The recommended arrangement is shown in fig. 3.

A Series Stabiliser

The KT55 is very suitable for use as a series stabiliser valve, the control or amplifier stage being a Z729. This application will be covered in a separate publication.

The circuit information given in this publication does not imply any licence under patents which may be involved.

COMPONENT VALUES

RESISTORS

(0·25W, 20% unless otherwise shown).

R1	2·2 kΩ		
R2	22 Ω		10%
R3	See text under "Operating Conditions."		
R4	220 kΩ	0·5W	10%
R5	1 MΩ		10%
R6	22 kΩ	0·5W } Matched	±5%
R7	22 kΩ	0·5W }	
R8	1·5 kΩ		
R9	1 MΩ		
R10	220 kΩ		
R11	220 kΩ		
R12	10 kΩ		
R13	10 kΩ		
R14	47 Ω		
R15	47 Ω		
R16	185 Ω	5W	5% w.w.
R17	185 Ω	5W	5% w.w.
R18	10 kΩ	1W	10%
R19	63 Ω	5W	5% w.w.
R20	30 Ω	10W	10% w.w. tapped at 15Ω
R21	10 kΩ		

CAPACITORS

C1	50 μF	12V	Electrolytic
C2	16 μF	350V	Electrolytic
C3	0·01 μF		Paper
C4	0·01 μF		Paper
C5	0·1 μF		Paper
C6	0·1 μF		Paper
C7	0·1 μF		Paper
C8	50 μF	25V	Electrolytic
C9	50 μF	25V	Electrolytic
C10	0·001 μF		Mica
C11	0·001 μF		Mica
C12	100 μF }	275V	Electrolytic
C13	200 μF }		
C14	50 pF		Mica
C15	200 μF	250V	Electrolytic

MISCELLANEOUS

L1	Smoothing choke 1·5-2H 300 mA 75Ω.
L2	Centre-tapped inductor 2011 50Ω
L3	Smoothing choke 1H 20Ω
MR1	Metal rectifier STC RM4
MR2	Metal rectifier STC RM5

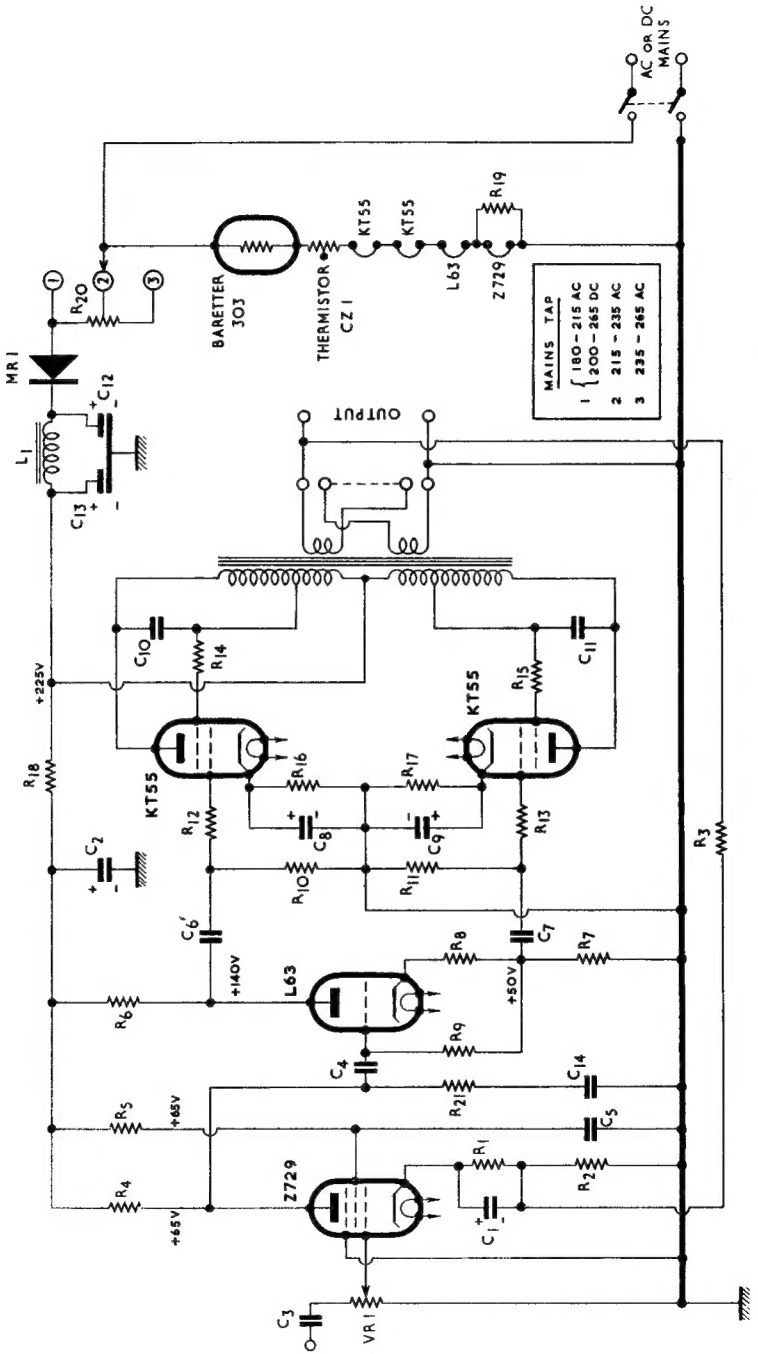


Fig. 1. 25W Ultra-linear amplifier. For pentode operation, resistors R14, R15, should be connected to C13.

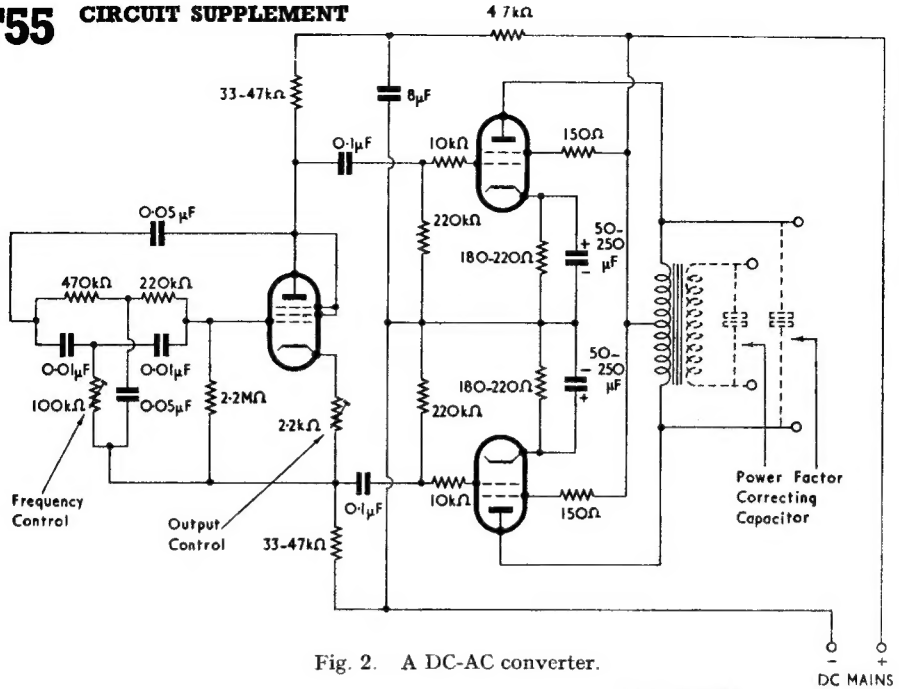


Fig. 2. A DC-AC converter.

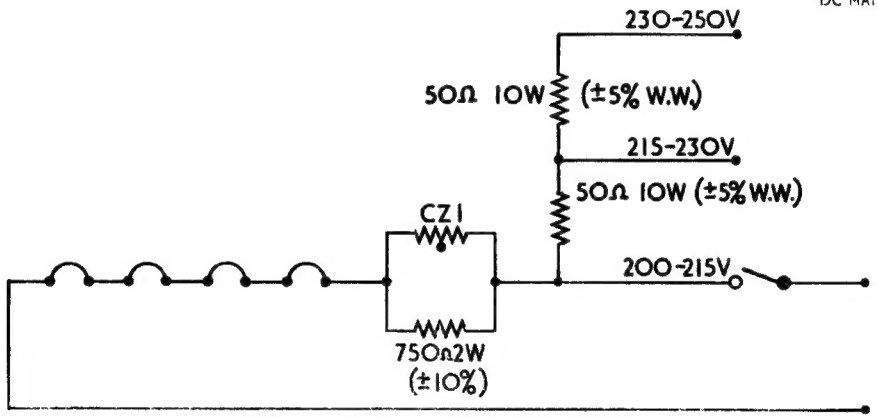


Fig. 3. Heater circuit for four KT55s.

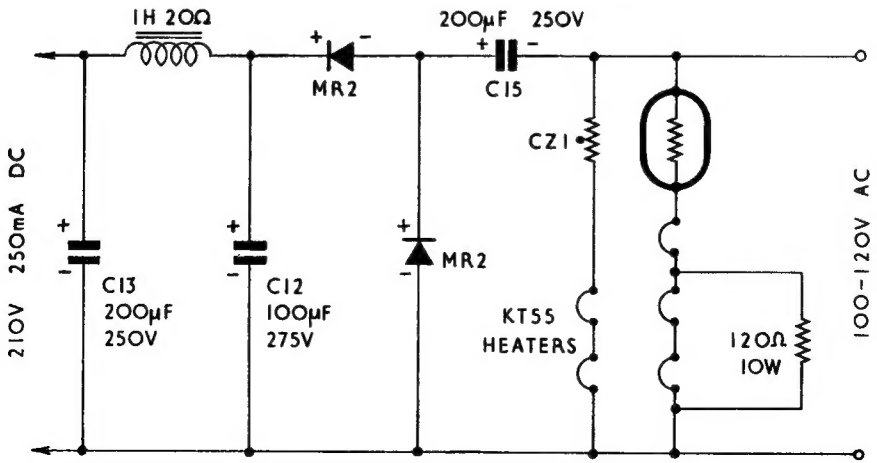
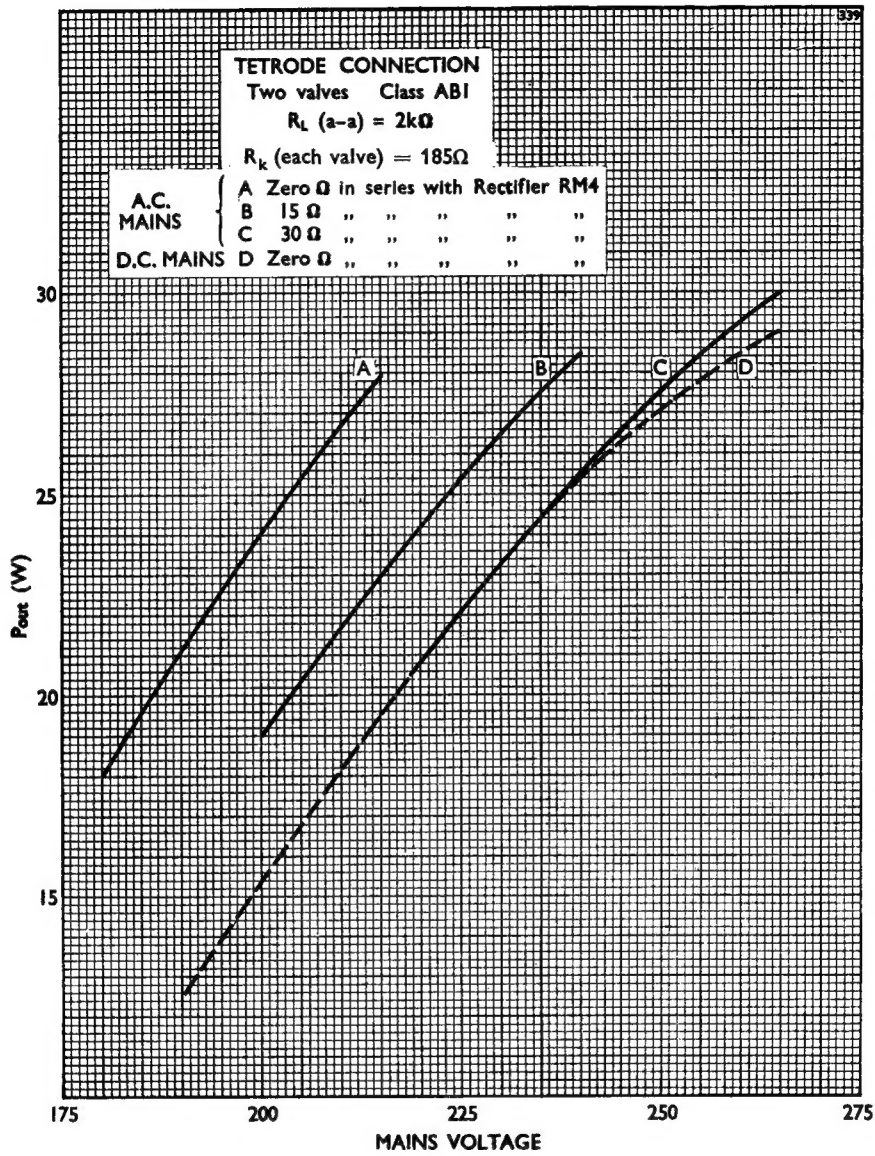


Fig. 4. Voltage-doubler circuit for 100-120V AC mains.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TETRODE CONNECTION
Two valves Class AB1
R_L (a–a) = 2kΩ
R_k (each valve) = 185Ω
A.C. MAINS
A Zero Ω in series with Rectifier RM4
B 15 Ω
C 30 Ω
D.C. MAINS D Zero Ω
30
25
20
15
P_{out} (W)
A
B
C
D
175
200
225
250
275
MAINS VOLTAGE

Fig. 5.

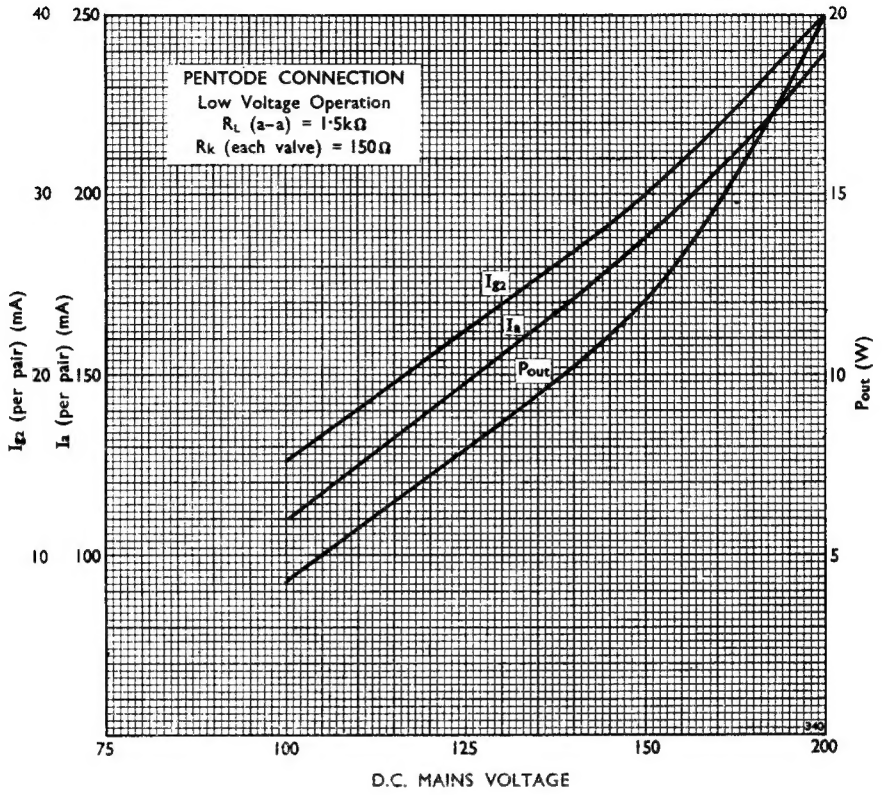
PENTODE CONNECTION
Low Voltage Operation
RL (a–a) = 1·5kΩ
Rk (each valve) = 150Ω
Ig2 (per pair) (mA)
Ia (per pair) (mA)
Pout (W)
Ig2
Ia
Pout
40
30
20
10
250
200
150
100
20
15
10
5
75
100
125
150
200
D.C. MAINS VOLTAGE

Fig. 6.